2024 Sec 4 Advanced Physics Exercise 2A

Electric Fields

Name: _____ (   ) Class: 4/ ___ Date: _____

Given formulae and constant:

$$E = \frac{F}{q} \qquad\qquad F = \left| \frac{kQq}{r^2} \right|$$

where k = 8.99 × 10^9 kg m^3 s^{-4} A^{-2}

$$v = r\,\omega \qquad\qquad a = \frac{v^2}{r}$$

For relevant calculations, you may take the mass of a proton to be 1.67 × 10^{-27} kg and its charge to be 1.60 × 10^{-19} C.

A Two identical point charges were initially separated by a distance of *d*. Due to the mutual repulsion, they move away from each other. When the separation increased by 5.0 mm, the repulsion force decreased from 100 μN to 25 μN.

**(a)** Calculate the value of *d*.

d = …………………………….

(b) Determine the magnitude of the charges.

magnitude of charges = …………………………….

B A proton travelling along the x-axis is slowed down by a uniform electric field E. At $x = 30$ cm, the proton has a speed of 2.5×10^6 m s^{-1} and at $x = 60$ cm, its speed is zero. Find the magnitude and direction of E.

$E =$ ....

C A beam of protons are projected with an initial speed of $v_i = 9.55 \times 10^3$ m s^{-1} into a region of uniform electric field $E = 720$ N C^{-1} directed vertically downwards. The protons are to hit a target that lies at a horizontal distance of 1.27 mm away from the point where the protons cross the plane and enter the electric field.
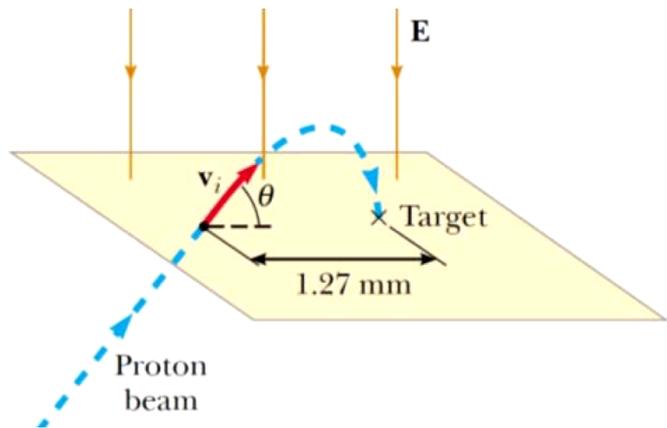
(a) Determine the two possible angles θ_1 and θ_2 that will result in a successful hit. Ignore gravitational acceleration.

$\theta_1 =$ ....

$\theta_2 =$ ....

(b) Determine the time interval during which the proton is above the plane and within the region of the electric field for each trajectory.

t_1 = …………………………….

t_2 = …………………………….

E = …………………………….

Answers:	1(a). 5.0 mm	1(b). 5.3 × 10⁻¹⁰ C	2. 138.1 g	3. −1.09 × 10⁵ N C⁻¹

Answers: 1(a). 5.0 mm   1(b). 5.3×10^{-10} C   2. 138.1 g   3. -1.09×10^5 N C^{-1}
4(a). 36.9° / 53.1°   4(b). 166 ns / 221 ns   5(a). out of the page
5(b). 0.39 m   5(c)(i). upwards   5(c)(ii). 5.4×10^5 N C^{-1}